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Broadband non-unity magnetic permeability in planar hyperbolic metamaterials GEORGIA THEANO PAPADAKIS, DAGNY FLEISCHMAN, ARTUR R. DAVOYAN, KRISHNAN THYAGARAJAN, HARRY A. ATWATER, Caltech — Metal/dielectric heterostructures with extreme anisotropy and topologically nontrivial dispersion are of fundamental and applied interest due to unique optical and opto-electronic properties. Here we demonstrate that, surprisingly, such systems exhibit a broadband non-unity magnetic response. Typically the electromagnetic properties of such metal-dielectric stacks are deduced from effective medium theories for unbounded, i.e., infinite in size periodic arrangements (c.f., Maxwell-Garnett approximation). In this talk, we show that this description is incomplete for metamaterials with finite number of layers. We demonstrate that a few-layer metal-dielectric metamaterial exhibits a non-unity magnetic permeability across the whole visible spectrum. The response can be diamagnetic or paramagnetic depending on the type of the terminating layers: metallic or dielectric, with non-resonant magnetic permeability that can be engineered to attain values as low as -2 or as high as 2. We have developed a theoretical model that explains the underlying mechanism. We further experimentally validate non-unity effective permeability in the optical range of frequencies. Ag/SiO_2 and Ge-based metamaterials fabricated with electron beam evaporation are characterized by ellipsometric measurements and also phase and amplitude of transmittance/reflectance. These results open pathways for creating broadband subwavelength magnetic structures in the visible regime.

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